

1 LEAK POINT WETNESS SENSOR FOR UROLOGICAL INVESTIGATIONS

2 Specification

3 Field of the Invention

4 For use in urological investigations of the female bladder
5 and urethra, a detector responsive to leakage of liquid from the
6 urethra.

7 Background of the Invention

8 Urologists and other physicians are interested in learning
9 when and under what conditions leakage from urethra first occurs
10 during an investigation of the bladder and urethra. In the
11 course of the investigation, liquid is forced into the bladder
12 through a catheter, and the pressure and the amount of liquid
13 (urine and water) is known. The patient is asked to assume a
14 number of positions, and to make various exertions, such as
15 muscular contraction and coughing. In the course of these
16 events, liquid will at times and under certain circumstances leak
17 past the catheter. The conditions under which this leakage just
18 begins is of importance to the physician in his investigation of
19 the bladder and urethra.

20 While leakage can be visually detected, the relationship of
21 its exact time of occurrence with respect to other measured
22 parameters during a urodynamic procedure is critical for the
23 proper evaluation of the test data. It is an object of this
24 invention to provide a simple and rugged sensor and related

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1 circuitry which will inform the urologist of the event of leakage,
2 and if desired will also record the relative time and conditions
3 under which it occurred, all without immediate attention by the
4 physician.

5 A sensor to detect and notify of leakage past the urethra is
6 disclosed in Ketchum patent No. 5,862,804, which does in fact
7 detect such leakage, relying on a difference between ambient
8 (room) temperature and the temperature of the leaked liquid.
9 This instant invention, by the same inventor, is intended to
10 provide optional or less complex references and measurements for
11 the same purposes.

12 Brief Description of the Invention

13 A sensor according to this invention, including its
14 reference and temperature responsive circuitry, detects wetness by
15 measuring the temperature of a liquid which contacts it. It is
16 an advantage of this invention that the sensor responds quickly
17 to the temperature of the liquid, but drains and dries quickly so
18 as to be sensitive to next events, such as leakage caused by
19 successive, relatively rapid coughs without being masked by the
20 previous event.

21 It is an object of this invention to simplify the sensor
22 system shown in the Ketchum patent in order to reduce its cost
23 and also to reduce the number of comparative measurements which
24 need to be made in order to detect the liquid.

1 In its every embodiment the sensor functions by sensing the
2 temperature which is respective to liquid expelled from the
3 urethra. It should be observed that this instrument surrounds a
4 catheter which is inserted into the bladder through the urethra.
5 The instrument is held immediately adjacent to the urethra. The
6 liquid when it reaches the sensor will have leaked past the
7 catheter and will be at or very near to body temperature. This
8 temperature will invariably be higher than ambient, and higher
9 than any other temperature likely to be encountered by the
10 instrument.

11 Accordingly, in one embodiment of this invention, instead of
12 using the output from a sensor responding to ambient temperature,
13 a reference circuit provides a generated output simulative of
14 some temperature sufficiently lower than the output of a sensor
15 that is responsive to temperature of the liquid. Then only one
16 sensor is needed. This can greatly simplify the instrument, and
17 will reduce its cost and complexity.

18 In another embodiment of the invention, the rate of rise of
19 the temperature where the liquid is to be detected can be used.
20 A sufficient rate of rise would not be occasioned merely by a
21 change in room temperature, which would be gradual. Instead it
22 would be caused by contact with a warm liquid. A sufficient rate
23 of rise will correctly reflect contact with a liquid at a
24 sufficient temperature.

1 The above and other features of this invention will be fully
2 understood from the following detailed description and the
3 accompanying drawings, in which:

4 Brief Description of the Drawings

5 Fig. 1 is an axial cross-section of the preferred embodiment
6 of a wetness sensor according to the invention;

7 Fig. 2 is an axial cross-section taken at line 2-2 in Fig.
8 1;

9 Fig. 3 is an end view taken at line 3-3 in Fig. 2;

10 Fig. 4 is a schematic circuit drawing of another embodiment
11 of the invention; and

12 Fig. 5 is a schematic circuit drawing of yet another
13 embodiment of the invention.

14 Detailed Description of the Invention

15 *91* A leak point detector 10 according to the invention is shown
16 in Figs. 1-3. Its body 11 may have any desired external
17 configuration, from a single cylindrical shape to one which is
18 shaped for a better grip. A passage 12 passes a catheter 13.

19 The catheter is a tube having an internal lumen 14 through
20 which liquid, usually water or a saline solution, is passed into
21 the bladder. The proximal end 15 of the catheter is connected to
22 a source of liquid (not shown). The distal end 16 of the
23 catheter is passed through the urethra into the bladder. Leakage
24 to be detected will flow between the urethral wall and the

1 external wall 17 of the catheter when the urethra is no longer
2 able to prevent the leakage.

3 Catheter wall 17 makes a close fit with wall 18 of passage
4 12 at its proximal end 19. Passage 12 is expanded at the distal
5 end 20 of the body to form a receptacle 21. Drain channels 22
6 extend from the receptacle to the exterior of the body so as to
7 drain liquid that flows into the receptacle. There is no
8 intention or purpose to collect the liquid, and it must promptly
9 be drained for a reason yet to be disclosed.

10 A temperature sensitive detector sensor 28 is bonded to the
11 wall 29 of the receptacle by a layer 30 of cement. The detector
12 is exposed so as to be contacted by liquid which has leaked from
13 the patient. It is also exposed to ambient temperature through
14 the drain channels.

15 According to one embodiment of the invention, shown in Fig.
16 4, the signal from detector sensor 28 is provided through leads
17 31 to a comparator 32. This signal is, for example, a voltage
18 proportional and respective to the temperature of the sensor-
19 that is, the temperature measured of leaked liquid that contacts
20 it. When dry, the signal merely reflects what is around it,
21 usually ambient air. When wetted, it will be the temperature of
22 the liquid expelled from the urethra, which will always be higher
23 than ambient.

24 A circuit 33 acts as a signal generator which generates and

1 provides a signal, usually a voltage, simulative of some lower
2 temperature than would be expected from the liquid. It will
3 usually be proportional to ambient. Its setting is preferably,
4 but not necessarily adjustable, but it is not temperature
5 responsive. Instead it is non-reactive and will ordinarily be
6 set to produce a voltage respective to a simulated temperature
7 somewhat greater than ambient, but less than that of leaked
8 liquid. There always will be a difference between the two
9 signals, so the comparator will be adjusted to provide no output
10 signal of its own when the sensor is dry. Then, when the sensor
11 is wetted by warm liquid, the comparator will have been set to
12 respond when the sensor temperature increases by some arbitrary
13 number of degrees above the simulated temperature, perhaps 10
14 degrees.

15 The signal from the comparator is provided to a recorder 35
16 and to a signal 36. Obtaining this signal is the objective. It
17 states the event of leakage. The actual temperature of the
18 leaked liquid is immaterial.

19 The second embodiment, shown in Fig. 5, does not respond to
20 any specific temperature. Rather it responds to rate of change
21 of temperature. Thus, gradual changes in room temperature, and
22 changes in the temperature of the body of the instrument itself
23 are ignored by it. However, when leaked liquid at an elevated
24 temperature contacts the sensor, there will be a rapid rise of

1 temperature at the sensor, which is uniquely indicative of the
2 presence of the warm liquid.

3 For this purpose, the signal from detector sensor 28 is
4 provided to a rate of change detector 40. This will react to a
5 change of the sensor output respective to a quick rise in
6 temperature. A typical differentiating circuit will perform this
7 task, and no specific description is required for an
8 understanding of the invention. A required rate of rise can
9 readily be determined, and the detector can be adjusted to that
10 level, both by brief observation of the existing circumstances.
11 Detector 40 provides its signal to a recorder 41 and/or a signal
12 42. It stops its signal when the temperature falls, so as to be
13 ready for the next liquid. It will be observed that there is no
14 source of a simulated temperature for comparison purposes. No
15 comparison is made. Only the abrupt rise occasioned by the
16 leaked fluid is detected.

17 In the procedure, the catheter is first passed into the
18 bladder through the urethra. Then to position the wetness sensor
19 on the catheter, the proximal end of the catheter is either
20 passed through the passage 12, or is clamped around the catheter
21 depending on the particular design of the wetness sensor. In
22 either case, when it is placed at a desired location along the
23 catheter, a plunger 44, or other friction device will be set to
24 bear against the catheter so the body cannot slide along the

1 catheter. The plunger, or other friction device, may be spring-
2 driven, threaded, or otherwise mounted as desired for this
3 purpose.

4 A thermistor is the preferred example of a temperature
5 sensing element for use in this device. Its surface is resistant
6 to water and to urine, and it is sensitive to small changes of
7 temperature. Its resistance decreases with increasing
8 temperature. However, other types of temperature sensors,
9 including direct-reading electronic thermometers may be used
10 instead. Therefore the thermistor is referred to generally as a
11 temperature sensitive element, but it is the preferred device.

12 In use, leakage liquid generally first flows slowly, drop-
13 by-drop as shown in the Fig. 1 as drops 50. They flow along the
14 surface of the catheter to the narrowed part of the receptacle,
15 where they contact the detector sensor. Then they flow out
16 through the drain channels so the thermistor can drain dry again
17 and be ready for the next drops. It is undesirable for the
18 detector thermistor to remain in continuous contact with the
19 liquid, because this would frustrate the comparison between the
20 temperature of freshly-received liquid and the ambient
21 temperature, and would prevent intermittent flows from being
22 sensed.

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1 This invention is not to be limited by the embodiments shown
2 in the drawings and described in the description, which are given
3 by way of example and not of limitation, but only in accordance
4 with the scope of the appended claims.